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ABSTRACT

Expanded abstracts and critical analyses are given for each of 17 research articles. Six articles are concerned with evaluating methods of instruction, two deal with student achievement in mathematics, one is concerned with classroom interaction and one with class size, four investigate learning and learning hierarchies, and three articles focus on student learning characteristics. Mathematics education research studies reported in October-December 1973 RIE and CIJE are also listed. (DT)

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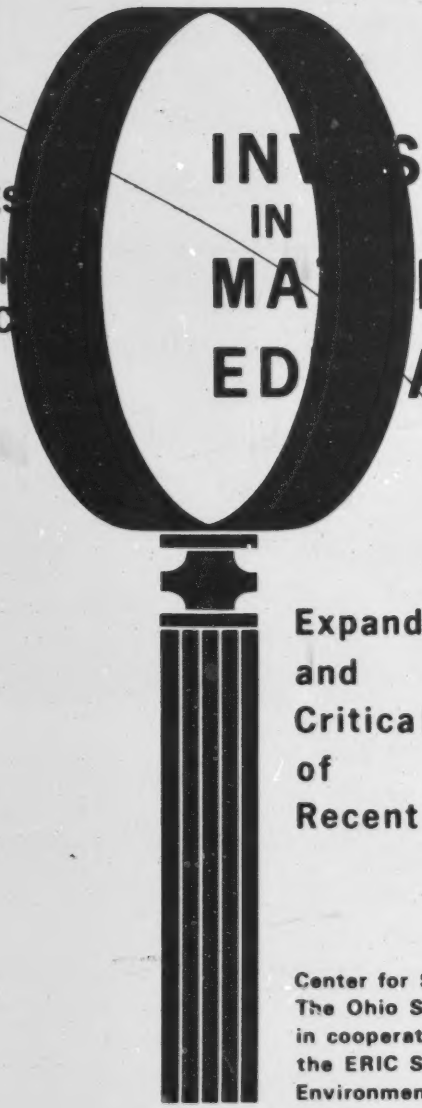

Expanded Abstracts and Critical Analyses of Recent Research

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The Ohio State University
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INVESTIGATIONS IN MATHEMATICS EDUCATION

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AN EXPERIMENTAL STUDY OF THE EFFECTS OF THREE INSTRUCTIONAL METHODS IN BASIC PROBABILITY AND STATISTICS. Austin, Joe Dan, Journal for Research in Mathematics Education, v5 n3, pp146-154, May 74.

Descriptors--*Manipulative Materials, *Mathematics Education, *Probability, *Research, *Teaching Methods, College Mathematics, Instruction, Intermode Differences, Symbolic Learning

Expanded Abstract and Analysis Prepared Especially for I.M.E. by William M. Fitzgerald, Michigan State University.

1. Purpose

To investigate the effectiveness of manipulation of physical objects in the teaching of probability and statistics to university-level students.

2. Rationale

The researcher cites the extensive support by educators for the use of manipulatives in teaching. This position was recommended by Bruner in his three-stage model of intellectual development: enactive, iconic and symbolic. A counter position was expressed by Ausubel who felt verbal instruction was superior for students over twelve. Reviews of the research by Kieren, Higgins and Austin had failed to show conclusive results.

3. Research Design and Procedure

Three experimental units covering the same content in probability and statistics were developed based on Bruner's model and were denoted manipulative-pictorial [MP], pictorial [P], and symbolic [S]. Each unit consisted of twelve lessons each with behavioral objectives and problems. The objectives and problems were identical for all three modes.

The experiment was conducted with 80 students at Purdue University randomly placed in the three classes. The students attended classes three times each week. The classes were conducted in an audio-tutorial mode with a written lesson to accompany each tape.

The classes were found to be comparable on the basis of previous mathematics grades using a two-way analysis. A final exam of 40 items was given at the end of the 12 lessons. The items were stratified according to the NLSMA taxonomy of comprehension, computation, application and analysis. A two-way analysis of variance was used on each of five dependent variables - the total score and the four subscores.

When the hypothesis of no difference in exam score means among the three treatment groups was rejected for a particular variable, Scheffe's method was used to make pair wise comparisons. All were made at the 5% level.

4. Findings

We will represent the symbolic treatment mean $\bar{x}_s$, the pictorial treatment mean $\bar{x}_p$, and the manipulative pictorial treatment mean $\bar{x}_{mp}$.

For the total examination score:

$$\bar{x}_s < \bar{x}_p; \quad \bar{x}_s < \bar{x}_{mp}; \quad \text{and} \quad \bar{x}_p = \bar{x}_{mp}.$$

The results were the same for the application and analysis subscores as for the total score.

For the comprehensive subscores

$$\bar{x}_s < \bar{x}_p; \quad \bar{x}_s = \bar{x}_{mp}; \quad \text{and} \quad \bar{x}_{mp} = \bar{x}_p.$$

For the computation subscore there were no differences in the means.

5. Interpretations

The following conclusions are drawn concerning the teaching of probability and statistics in an audio-tutorial mode to college students who are not science nor mathematics majors:

(a) Computational achievements does not differ among the three instructional methods.

(b) Students' application, analysis and total examination scores are significantly improved by using graphs, figures and diagrams when possible.

(c) If graphs, figures and diagrams are used, then students' application, analysis and total scores do not indicate any significant difference between students who perform manipulations or experiments and students who are only told the results of manipulations or experiments.

(d) If graphs, figures and diagrams are used, then students' comprehension scores may indicate that students who perform manipulation did not perform as well as those who were only told the outcome of the experiments.

The results seem to indicate that university level students can give up manipulation of physical objects with no loss in achievement.

Abstractor's Notes

The study appears to have been conducted with great care with much attention given to the elimination of sources of bias.

One might question whether it is reasonable to expect any effects of manipulative experience in such a short time and in such constrained and sterile conditions.

A longer range question - If adults can in fact profit from the pictorial mode as well as or better than from the manipulative-pictorial mode, how important is previous experience with manipulation in the development of those abilities?

William M. Fitzgerald
Michigan State University

EJ 090 180 SE 510 251

THE CORRELATION OF SELECTED NONMATHEMATICAL MEASURES WITH MATHEMATICS ACHIEVEMENT. Cathart, W. George, Journal for Research in Mathematics Education, v5 n1, pp47-56, Jan 74.

Descriptors--*Achievement, *Correlation, *Elementary School Mathematics, *Predictor Variables, *Research, Mathematics Education

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Harold L. Schoen, The University of Iowa.

1. Purpose

To examine the relationship of selected nonmathematical variables to mathematics achievement.

2. Rationale

Nonmathematical variables have been found to be significantly related to achievement in mathematics in many research studies. The author chose to further examine the relationship between mathematics achievement and each of the following variables: intelligence, conservation, socioeconomic status, chronological age, listening ability, vocabulary level, and sex. This selection of variables was based on "availability and previous research results that suggest that the variables correlate significantly with mathematics achievement."

3. Research Design and Procedure

The subjects were 60 Grade Two and 60 Grade Three students chosen randomly from 10 schools in Edmonton, Canada, and 2 schools in a rural agricultural and industrial area adjoining the city of Edmonton. The conservation test (taken directly from Piaget's work) and vocabulary test (vocabulary section of the Wechsler Intelligence Scale for Children) were administered individually to each student. The listening test (Cooperative Primary Tests - Listening, Form 12A), intelligence test (Raven's Coloured Progressive Matrices), and the researcher-developed achievement test were administered to groups of 10 students at a time. Age, sex and father's occupation were obtained from the school records. Seven achievement measures were obtained from the achievement test. These were geometry, numeration, concepts (geometry plus numeration), basic facts of addition and subtraction, basic facts of multiplication and division, basic facts (addition, subtraction, multiplication, and division), and a total test score.

A stepwise regression procedure was employed to determine which of the nonmathematical variables correlate with mathematics achievement. The probability level for adding or deleting a variable from the regression equation was .10. Means, standard deviations, pairwise correlations, multiple correlations, and regression equations were reported for both the Second Grade and the Third Grade subjects.

4. Findings

Grade Two subjects:

(a) Four of the seven independent variables appeared in the final regression equations: listening, vocabulary, conservation and intelligence.

(b) Listening ability accounted for a greater proportion of the variance than any other independent variable for four of the seven criterion measures.

Grade Three subjects:

(a) The most significant correlates with mathematics achievement were listening ability, intelligence, and vocabulary.

(b) In the first step of the analysis for five of the seven criteria, listening ability accounted for between 15% and 44% of the variance.

5. Interpretations

"One can only speculate as to why listening ability was the best single correlate in the present study." However, a major implication is a recommendation that researchers consider listening ability as an independent variable in future studies. General intelligence was significant for Grade Three, but not for Grade Two.

An unexpected result was the almost negligible contribution of the conservation test. However, "these results were probably due to the fact that the conservation test consisted of only eight items for testing in four different areas - number, length, area, and volume."

Abstractor's Notes

Several questions come to mind after reading this report. Why was the study done at all? Previous research, according to the author, suggests that the selected variables correlate significantly with mathematics achievement. Would it not be more productive to examine some causal relationships among some of these variables or to refine one or more of the variables to get further information? Perhaps there was a need to re-establish the correlations but it is not brought out in this report.

The use of a random sample is commendable. The data analysis is appropriate. However, reported test reliabilities are incomplete. A KR-20 reliability of 0.893 is reported for the final version of the achievement test. I assume that estimate is for the total year. Yet scores from six parts of the test are also used as criterion measures. What were the reliabilities of these parts?

Further questions concerning the procedures used in designing the tests for achievement and conservation, and the point in the instructional sequence at which the achievement test was administered, are also significant. In fairness to the author, space limitations no doubt necessitated some significant omissions in this report. Nonetheless, the answers to these questions would help a reader to better interpret the results.

On the positive side, the high correlation between listening ability and mathematics achievement found in this study is interesting. The author states that this may have occurred because the instructional strategy was primarily a "tell-and-do" approach. However, this is hardly a limitation; "tell-and-do" is the prevalent teaching method in most schools.

Harold L. Schoen
The University of Iowa

EJ 090 176 SE 510 247

THE RELATIVE EFFECTIVENESS OF FOUR STRATEGIES FOR TEACHING DISJUNCTIVE CONCEPTS IN MATHEMATICS. Dossey, John A.; Henderson, Kenneth B., Journal for Research in Mathematics Education, v5 n1 pp6-19, Jan 74.

Descriptors--*Concept Teaching, *Instruction, *Learning Theories, *Mathematics Education, *Research, Concept Formation, Logic, Programed Instruction, [Research Reports]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Larry Sowder, Northern Illinois University.

1. Purpose

The study investigated "the relative effectiveness of four strategies for dealing with disjunctive concepts in mathematics." The effects of nonexamples vs examples, algebraic vs geometric concepts, and inclusive vs exclusive disjunction were also studied, with Ss at two ability levels.

2. Rationale

Earlier studies comparing the effectiveness of teaching strategies usually have shown no significant differences. Perhaps focusing on a single kind of concept might reveal some differences. Focusing on disjunctive concepts, in particular, seems promising since (a) the evidence indicates that disjunctive concepts are more difficult to attain than conjunctive concepts and (b) a nonexample logically provides more information for a disjunctive concept than for a conjunctive concept.

3. Design and Procedure

A completely crossed, balanced 4x2x2 factorial design was used, with 4 strategies:

CE--4 characterization moves, then 6 exemplification moves (see Henderson, 1970, for definitions of these terms)

CEC--2 characterization moves, then 6 exemplification moves, then 2 more characterization moves

ECE--3 exemplification moves, then 4 characterization moves, then 3 exemplification moves

EC--6 exemplification moves, then 4 characterization moves, then 2 exemplification approaches:

examples--the exemplification moves consisted of 4 example moves and 2 nonexample moves

nonexamples--the exemplification moves consisted of 2 example moves and 4 nonexample moves, and 2 student-ability levels, H and L.

Subjects were the top 160 (H) and bottom 160 (L) students, based on Henmon-Nelson performance, in 2 lecture sections of prospective elementary teachers in a college mathematics course; data from the middle 43 students were not pertinent to the study. Subjects in each stratum of 8 Ss were randomly assigned to the 8 strategy x exemplification cells.

The 12 disjunctive concepts "were contrived concepts involving familiar mathematical concepts"--e.g., "a nint is a natural number that is a multiple of two or a multiple of five. A prifor is a natural number that is either prime or has a units digit of four." Concepts were devised to include both the exclusive or (exactly one of the defining characteristics is present in an example--see prifor above) and the inclusive or (at least one of the defining characteristics is present in an example--see nint above). Both algebraic-numeric and geometric concepts were included. Instruction was carried out through programed booklets based on the appropriate strategy-exemplification combination.

A 72-item post-test was given five days after the instructional period. Items on the test were equally distributed among 3 levels: Level I. Knowledge and Comprehension; Level II. Application; and Level III. Analysis, Synthesis, and Evaluation. KR-21 reliability for the whole test was .85.

4. Findings

(a) There were no significant differences among groups in time required to complete the instructional materials.

(b) At each level of the post-test, there were highly significant (.001) differences in performance between the high and low ability groups (H > L).

(c) These other statistically significant (.05) differences for main effects were found, with Duncan's New Multiple Range Test providing the directions noted below:

Level I: examples ($\bar{X}$ = 15.1) > nonexamples ($\bar{X}$ = 14.2)
Level II: CEC (16.0) > ECE (14.1)
Level III: CEC (15.0), EC (14.9), CE (14.7) > ECE (13.4)
Total test: CEC (46.0), EC (45.0) > ECE (41.5).

(d) The only significant interaction found was a 3-way interaction at Level III.

(e) Performance on exclusive concepts was significantly better than performance on inclusive concepts (t-test for correlated samples, no means reported).

(f) Performance on geometric concepts was significantly better than performance on algebraic concepts (t-test for correlated samples, no means reported).

5. Interpretations

(a) "...the logical form of a concept may have an effect on the success of a particular instructional strategy," since earlier work with conjunctive concepts did not give findings completely consistent with those in 4c.

(b) Differences among strategies may become apparent by looking at performance at different cognitive levels.

(c) The most common and most pronounced differences appeared between the CEC and ECE strategies (CEC >ECE). Perhaps the early exemplification moves in the ECE strategy are wasted in processing the relatively difficult disjunctive concepts.

(d) Although not always statistically significant, the order of means for the 4 strategies was consistent from level to level of the post-test: CEC >EC >CE >ECE. Ending with characterization moves seems to be more effective in dealing with disjunctive concepts.

(e) The superiority at Level I of the examples approach may be due to the "more direct recall nature of the questions" or to the inability of Ss to profit from "knowing what a concept is not."

(f) The inclusive or may be more difficult than the exclusive or since examples of inclusive or concepts may invite confusion between the use of and and or.

(g) The geometric concepts may have been easier than the algebraic since the diagrams accompanying a geometric example may carry additional information.

Abstractor's Notes

1. The researchers are to be commended for a well-conceived, well-carried out study. Happily, they also reported it in a very clear write-up.

2. Some helpful details are omitted in the write-up: length of instruction time, whether the post-test was announced, and most important some samples of the post-test items. Supplying more information about home-made measuring tools should be routine in research reports. Here, for example, it is somewhat puzzling that mean scores did not vary much from Level I (14.7) to Level II (15.1) to Level III (14.5), even though the upper levels are usually assumed to be more demanding. Looking at a few items might explain this lack of differences.

3. The labels for some concepts (e.g., prifor) seem to carry a mnemonic that others (e.g., nint) do not. Might there be some interaction between type of label and strategies or exemplification approaches?

4. Were, perhaps, the differences due to the inclusive or concepts only? Everyday usage of "or" would seem to foster the exclusive sense; hence, Ss may have had difficulty with inclusive or concepts only.

5. Do college students react to recognizably contrived problems in the same way they react to "real" subject matter?

Larry Sowder
Northern Illinois University

Reference

Henderson, Kenneth B. "Concepts," Ch. 7 in The Teaching of Secondary School Mathematics, 33rd Yearbook, National Council of Teachers of Mathematics, 1970.

EJ 071 812 270 SE 507 854

THE EFFECTS OF A LABORATORY ON ACHIEVEMENT IN COLLEGE FRESHMAN MATHEMATICS. Douthitt, Cameron, Two-Year College Mathematics Journal, v4 n1, pp55-59, W 73.

Descriptors--*College Mathematics, *Instruction, *Laboratories, *Mathematics Education, *Research, Achievement, Analytic Geometry, Attitudes

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Paul C. Burns, The University of Tennessee.

1. Purpose

This study sought to determine the effects of a mathematics laboratory on achievement, attitude, and the W/F (withdrawal-failure) rate on "risk and nonrisk" students who registered for analytic geometry in the fall semester of 1970 at the University of Houston. This report deals only with the effects of the laboratory on achievement.

2. Rationale

This investigation was done when the withdrawal-failure rate in freshman mathematics courses at the University of Houston was approximately 30%, while the rate among "risk" students was about 70%. ("Risk" students are those from the top quarter of their high school graduating class who achieved a score of less than 450 on the mathematics section and a total score of less than 900 on the Scholastic Aptitude Test.) The underlying assumption, though unstated, was that a mathematics laboratory would help students perform more acceptable work in mathematics.

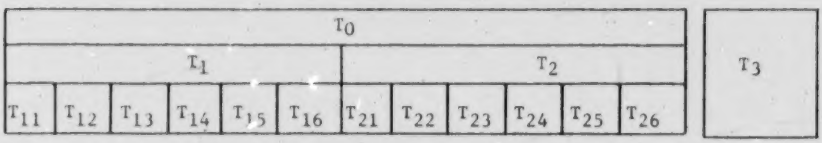
Previous work in the field related to this investigation, though uncited in this report, include E. E. Biggs and J. R. MacLean, Freedom to Learn: An Active Learning Approach to Mathematics, Reading, Massachusetts: Addison-Wesley, 1969; J. L. Higgins, "Attitude Changes in a Mathematics Laboratory Utilizing a Mathematics-through-Science Approach," Journal for Research in Mathematics Education 1: 1970, pp. 43-56; and E. J. Zoll, "Research in Programmed Instruction in Mathematics," The Mathematics Teacher, 62: 1969, pp. 103-110.

3. Research Design and Procedure

The control and experimental groups were composed of both risk and nonrisk college freshmen students who registered for analytic geometry in the fall semester of 1970. (Students were never informed of their status as "risk" students, though they were invited to participate in the laboratory classes.) Two special sections constituted the experimental group -- 26 risk students and 42 nonrisk students. This group attended one-hour lectures on Mondays and Fridays and worked in the laboratory for one hour on Wednesdays. The control group consisted of

both risk and nonrisk students (112) who registered for one of the five sections of analytic geometry other than those provided for the experimental group. Those students attended the usual lecture-type course for three hours per week and did not attend the laboratory.

The mathematics laboratory was designed according to the diagram below:



T_0 -- Experimental group (68 students)

T_1 -- 36 students of experimental group (no use of innovative materials; use of textbook only)

T_2 -- 32 students of experimental group (use of innovative materials; programmed texts, filmstrips, tapes, models, transparencies)

T_{11}, T_{12}, T_{13}, T_{14}, T_{15}, T_{16}, T -- Subgroups of T_1 with approximately 6 students in each subgroup

T_{21}, T_{22}, T_{23}, T_{24}, T_{25}, T_{26}, -- Subgroups of T_2 with approximately 5 students in each subgroup

T_3 -- Control group (112 students with no laboratory)

Twelve tutors directed the mathematics laboratory; each was assigned a small subgroup for the semester. The tutors were mathematics education majors who had completed at least 18 semester hours in mathematics and were currently enrolled in a mathematics methods course. The instructor of the experimental group served as overall laboratory supervisor.

The Cooperative Mathematics Test -- Analytic Geometry was administered as a posttest to both experimental and control groups at the conclusion of the semester.

Null hypotheses concerning achievement were tested by "t" tests for significance.

4. Findings

A significant difference, favoring the experimental group, in achievement in analytic geometry existed at the conclusion of the program between:

(a) the nonrisk students in the control group and the nonrisk students in the experimental group;

(b) the risk students in the control group and the risk students in the experimental group;

(c) students in the control group and students in the experimental group.

No evidence, in terms of higher achievement scores for either the risk or nonrisk students, was found to support one type of laboratory than the other type of laboratory.

5. Interpretations

Several conclusions were drawn by the investigator from the findings:

(a) A mathematics laboratory can produce higher achievement in college freshmen mathematics courses.

(b) Risk students can do more acceptable work in mathematics through a mathematics laboratory. (The laboratory helped reduce the W/F rate in that group from near 70% to 15%.)

(c) The type of laboratory material did not seem to affect achievement.

Other conclusions were reported relative to attitude, type of student most helped by the mathematics laboratory, and coverage of geometry content, but supporting data were not provided in this article.

Abstractor's Notes

As was done in this investigation, every avenue must be explored to determine why students do not succeed in college mathematics classes. Several questions may be raised:

1. Apart from a laboratory setting, what impact may be assigned the role of motivation and encouragement received by the experimental students from the tutors?

2. Did the instructors of the experimental group and the control group differ in any significant ways?

3. What "innovative" materials in a mathematics laboratory might be most effective?

4. For which students might a mathematics laboratory be more helpful or necessary?

5. For which mathematics courses might a mathematics laboratory be most helpful?

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EJ 078 169 270 SE 508 620

A COMPARISON OF THREE STRATEGIES FOR TEACHING A SELECTED MATHEMATICAL CONCEPT TO STUDENTS IN COLLEGE ALGEBRA. Gaston, Jane A.; Kolb, John R. Journal for Research in Mathematics Education, v4 n3, pp177-186, May 73

Descriptors--*Concept Formation, *Concept Teaching, *Instruction, *Mathematics Education; *Research, Algebra, College Mathematics, Community Colleges, Learning Theories, Set Theory

Expanded Abstract and Analysis Prepared Especially for I.M.E. by James K. Bidwell, Central Michigan University.

1. Purpose

Three teaching strategies, based on different sequences of instructional dialogue moves, were compared to determine their effectiveness in facilitating acquisition and transfer of a mathematical concept as measured by three different kinds of tests.

2. Rationale

Henderson has analyzed instructional dialogue into two main categories of segments (moves) -- characterization moves where attributes of a concept are described and exemplification moves where examples and nonexamples are presented. Classroom strategies can be described as different sequences of these two kinds of moves.

Henderson proposed one strategy (CE) of an identification move (characterization) followed by three examples with justification. Gagné suggests a strategy (ECE) of several exemplification moves followed by characterization moves to isolate attributes. The strategy is completed with new instances to be classified as examples or nonexamples. Henderson and Rollins proposed a third strategy (E) of successive example and nonexamples moves.

The study also involved three different types of measures. Gagné suggests a vertical transfer test (1) composed of "theorems" based on the concept. An exemplification test (2) requires classification of examples and nonexamples of the concept. A characterization test (3) requires that a list of properties be identified as being or not being characteristic of the concept.

3. Research Design and Procedure

The Ss were 39 freshman students enrolled in two college algebra classes in the winter quarter 1970 at Shoreline Community College, Seattle, Washington. The concept of "partition of a set" was presented to each class via programmed booklets. The whole procedure took one hour of class time. The two experiments were different in that the first class had been apprised of the experiment the day before and 18 students volunteered. The second experiment was administered to a second class of 21 students with no forewarning.

The three treatments consisted of a brief review of set concepts, followed by each of the three strategies, and completed by the three achievement measures. The three strategies were:

(a) CE. An exact definition of set partition was followed by two examples with justification and a third example that each subject verified for himself (answers supplied).

(b) ECE. Three examples of set partitions were given, followed by six characteristic moves to point out the three attributes of set partition. The three initial examples were repeated followed by four exemplification moves to be classified as examples or nonexamples by each S (answers supplied).

(c) E. Thirty-eight exemplification moves were presented. First a partition example was given. Then each succeeding set was offered and the S was asked if it was a partition or not. After a response, the correct answer was given.

The three achievement measures were:

(a) The vertical transfer test consisted of 10 positive statements about set partition which the S was to identify as true or false.

(b) The exemplification test consisted of 30 questions presenting sets to be identified as partitions or not. Four questions were partitions. Of the remaining questions, 12 lacked one of three attributes, 12 lacked two attributes, and 2 lacked all three attributes.

(c) The characterization test contained 15 true or false statements about set partition. Various combinations of attributes were included.

The tests were administered in the above order. Twenty-five minutes were allowed for instruction; 27 minutes for testing. All subjects had sufficient time. Students were randomly assigned equally to the treatment groups.

4. Findings

On both experiments the E strategy was superior at the .05 level on Test 2 to the CE and ECE strategies combined. In the second experiment the CE strategy was superior at the .10 level to the ECE strategy on Test 3. No other significant differences were found.

MEANS AND STANDARD DEVIATIONS OF EACH TREATMENT GROUP ON EACH MEASURE FOR EXPERIMENTS I AND II

Treatment	N	Test 1 (10 items) Mean	S.D.	Test 2 (30 items) Mean	S.D.	Test 3 (15 items) Mean	S.D.
Experiment I							
CE	6	5.67	1.63	25.50	1.38	13.00	1.46
ECE	6	4.83	2.23	26.50	2.43	12.17	2.48
E	6	6.33	1.63	28.33	1.86	10.83	2.56
Experiment II							
CE	7	4.00	1.63	21.40	3.10	10.90	3.19
ECE	7	5.14	1.77	20.57	5.83	8.14	1.57
E	7	5.14	1.57	26.86	3.02	10.29	2.36

5. Interpretation

In 1970 Rector and Henderson conducted a similar study of four instructional strategies. A pure characterization method was significantly better than the other three strategies. In this current study, the strategies compared appear to be equally effective in promoting transfer of the mathematical concepts. The E strategy may have been superior simply because Test 2 was an exemplification test or because of the large number of moves (38) in the E strategy. The lower achievement of the second experiment is in contrast to the instructor judgement of the higher ability of the second class. It is plausible that the different level of motivation and intention to learn caused the differences.

Abstractor's Notes

It is unfortunate that the study suffered by having so small a number of Ss. Further the differences between the two experiments prevented unification of the data. The purpose of the study is worthy enough to demand a larger study in which a dominant strategy might more strongly emerge. If an improved study again showed the exemplification strategy superior, it would be a strong case for using chains of examples for learning simple concepts rather than the more popular Gagné- or Ausubel-oriented concept learning. Complex concept chains would require guided learning through verbalized sub-concepts.

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EJ 078 167 270 SE 508 618

A MODEL OF CLASSROOM DISCOURSE FOR USE IN CONDUCTING APTITUDE-TREATMENT INTERACTION STUDIES. Hernandez, Norma G. Journal for Research in Mathematics Education, v4 n3, pp161-169, May 73.

Descriptors--*Classroom Communication, *Classroom Observation, Techniques, *Interaction Process Analysis, *Research, *Secondary School Mathematics, Mathematics Education

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Merlyn J. Behr, Northern Illinois University.

1. Purpose

The purposes of the study were: one, to design a model of classroom discourse and an observation procedure for quantifying person-environment interaction; and two, to test this model and observation procedure on several teacher-student classroom interaction situations. The author's purpose for this observation procedure was couched in the theory of aptitude-treatment interaction research; this gave the study a major thrust of developing a model and observation procedure that could be used to identify environmental (instructional treatment) variables in mathematics instruction which might be expected to lead to interactions between learner aptitudes and environmental (instructional treatment) variables.

2. Rationale

If interactions between abilities and treatments exist and can be demonstrated in controlled experimental settings, then such interactions should also be observable in a natural classroom setting. To describe the "natural setting" of a classroom, one variable with apparent high potential is that of teacher discourse. The author's proposed scheme for conducting aptitude-treatment interaction studies is to describe students in terms of a profile of cognitive abilities generated by Guilford's (1967) structure of the intellect while describing the environment (the verbal discourse of the teacher) via a theoretical framework that is qualitatively similar to Guilford's model. The author's proposed model for describing classroom discourse takes a model prepared by Kinneavy as a point of departure. The author's model consists of three dimensions labeled Styles of Presentation, Inferred Cognitive Processes, and Modes of Discourse. These three dimensions correspond to Guilford's and Kinneavy's models as indicated in the following table. An implied conjecture related to this analysis is that environmental (teacher discourse) variables identified within a given dimension of the proposed model should be related to student aptitude variables within respective dimensions of Guilford's model.

Implementation of the model begins with an analysis of a transcript of classroom discourse. The analysis involves the identification of units of discourse and the categorization of each unit in relation to the three dimensions of the model. Units are categorized according to the definitions of the subdivisions of the proposed model and defined in the

CORRESPONDENCE OF GUILFORD AND KINNEAVY STRUCTURES
AND PROPOSED MODEL

Guilford	Kinneavy	Proposed Model
Content	*Syntactics*	*Styles of Presentation*
Verbal	Semantic	Semantic
Number	Symbolic	Symbolic
Space	Figural	
		Semantic-Symbolic
		Semantic-Figural*
		Semantic-Symbolic-Figural
Operation	*Pragmatics*	*Inferred Cognitive Processes*
Cognition and Memory	Informative	Memory*
Convergent	Deductive and Inductive	Convergent Production*
Divergent	Exploratory	Divergent
Evaluation		
Product	*Modes*	*Modes of Discourse*
Units	Description	Description*
Classes	Classification	Classification*
Transformations	Narration	Narration Events*
		Narration Directions*
	Evaluation	Evaluation (Criteria)*
		Evaluation (No Criteria)*

(*found to be reliably codeable by the process described in Section 3)

coder's manual developed by the author. Each unit of discourse - a main clause and all its subordinate clauses - is coded three times, once for each dimension of the model. The product of the coding is thus a series of triples. Patterns are observable and percents of total discourse can be ascribed to certain categories or combinations of categories. Conceptualization of a teacher's style is subsequently made on the basis of patterns and frequency of usage of certain categories. This style constitutes a particular treatment.

3. Research Design and Procedure

A study to investigate the use of the proposed model was conducted with four junior high eighth grade mathematics classes. The discourse of three video-taped sessions from each of the classes was transcribed and coded by trained persons. Each dimension of the model was subdivided into several categories that were mutually exclusive as indicated in the table. In addition, units of discourse were independent across dimensions in the sense that no coding in any one dimension depended on the coding for any other. The number of units assigned to each category per teacher and per codes was determined and expressed as percents of total discourse. Coder reliability was defined as the degree to which independent coders agreed on the percent of the total discourse assigned to a particular

EJ 078 167 270 SE 508 618
A MODEL OF CLASSROOM DISCOURSE FOR USE IN CONDUCTING APTITUDE-TREATMENT INTERACTION STUDIES. Hernandez, Norma G. Journal for Research in Mathematics Education, v4 n3, pp161-169, May 73.

Descriptors--*Classroom Communication, *Classroom Observation, Techniques, *Interaction Process Analysis, *Research, *Secondary School Mathematics, Mathematics Education

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Merlyn J. Behr, Northern Illinois University.

1. Purpose

The purposes of the study were: one, to design a model of classroom discourse and an observation procedure for quantifying person-environment interaction; and two, to test this model and observation procedure on several teacher-student classroom interaction situations. The author's purpose for this observation procedure was couched in the theory of aptitude-treatment interaction research; this gave the study a major thrust of developing a model and observation procedure that could be used to identify environmental (instructional treatment) variables in mathematics instruction which might be expected to lead to interactions between learner aptitudes and environmental (instructional treatment) variables.

2. Rationale

If interactions between abilities and treatments exist and can be demonstrated in controlled experimental settings, then such interactions should also be observable in a natural classroom setting. To describe the "natural setting" of a classroom, one variable with apparent high potential is that of teacher discourse. The author's proposed scheme for conducting aptitude-treatment interaction studies is to describe students in terms of a profile of cognitive abilities generated by Guilford's (1967) structure of the intellect while describing the environment (the verbal discourse of the teacher) via a theoretical framework that is qualitatively similar to Guilford's model. The author's proposed model for describing classroom discourse takes a model prepared by Kinneavy as a point of departure. The author's model consists of three dimensions labeled Styles of Presentation, Inferred Cognitive Processes, and Modes of Discourse. These three dimensions correspond to Guilford's and Kinneavy's models as indicated in the following table. An implied conjecture related to this analysis is that environmental (teacher discourse) variables identified within a given dimension of the proposed model should be related to student aptitude variables within respective dimensions of Guilford's model.

Implementation of the model begins with an analysis of a transcript of classroom discourse. The analysis involves the identification of units of discourse and the categorization of each unit in relation to the three dimensions of the model. Units are categorized according to the definitions of the subdivisions of the proposed model and defined in the

category per teacher per lesson. Aspects of teacher discourse found to be reliably codeable by this process - those for which an interclass correlation coefficient greater than .70 and F significant at the .05 level or above - are marked with an asterisk in the Table.

4. Findings

Since, according to the author, it was not possible to control the subject matter presented by the teachers, it was not possible to make comparisons between teachers as to teaching style. Within these limitations, however, the data indicate that the observation system was sensitive to differences among styles of presentation. To illustrate a possible comparison some data on the Modes of Discourse dimension of the model are presented. The data showed that Teacher 1 had twice as many units marked "Description" as did Teacher 4, and Teacher 3 had four times as many in the same category. Differences also appeared in "Evaluation" and "Narration Directions" categories. Of the 135 possible triples which could have been coded the four non-managerial discourse units most coded were Semantic/Memory/Evaluation (Criteria), Semantic/Memory/Narration Directions, Semantic/Memory/Narration Events, and Semantic/Memory/Classification.

5. Interpretations

With a system for coding as suggested, the environment can be described, quantified, and measured in terms of variables that are qualitatively similar to variables describing the person. In addition, the model suggests various questions which can be answered or investigated.

Abstractor's Notes

This study presents a useful conceptual model for identification of instructional variables which could be systematically manipulated for the purpose of investigating for aptitude-treatment interactions. However, the specific model presented may have limited applicability because a number of aptitude-treatment interaction studies have resulted with data which bring the validity of Guilford's model into serious questions.

It would seem that subsequent application of the model would have to be made with full realization that the first component of the four most frequently observed units of discourse (ordered triple) was not among those that had been reliably categorized.

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EJ 080 494 520 TM 500 943

THE RELATIONSHIP OF AN EXPERIMENTAL FORM OF THE MATHEMATICS SELF-CONCEPT SCALE TO COGNITIVE AND NONCOGNITIVE VARIABLES FOR A SAMPLE OF SEVENTH-GRADE PUPILS IN A MIDDLE-CLASS SOUTHERN CALIFORNIA COMMUNITY. Holly, K. A.; And Others, Educational and Psychological Measurement, v33 n2, pp 505-508, Sum 73.

Descriptors--*Self Concept Tests, *Predictor Variables, *Grade 7, *Measurement Mathematics, Middle Class, Cognitive Ability, Data Analysis, (*Mathematics Self Concept Scale, MSCS)

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Lewis R. Aiken, University of New England.

1. Purpose

To determine the degree of relationship between an experimental form of the 10-item Mathematics Self-Concept Scale (MSCS) with each of eight demographic-biographical, seven cognitive, and three affective measures.

2. Rationale

A preliminary form of the MSCS, consisting of 20 seven-step ("Very Strongly Agree" to "Very Strongly Disagree") items concerning feelings toward mathematics was administered in September and again in November 1970 to 34 ninth-graders in a suburban Los Angeles school. Nine items that significantly differentiated between students in the upper and lower halves of the total score distribution were retained in the final form of the MSCS. The test-retest (2 months) reliability of the nine-item MSCS was .81. Correlations between the nine-item MSCS and various measures of ability ranged from .10 to .61. It should be noted here that only the largest coefficient, that between the MSCS and a score (not given) on the California Test of Mental Maturity is statistically significant at the .05 level.

3. Research Design and Procedure

The final, ten-item form of the MSCS consisted of four statements expressing positive feelings and four statements expressing negative feelings toward mathematics. Responses to each statement were indicated on a five-point ("Strongly Agree, Slightly Agree, Undecided, Slightly Disagree, Strongly Disagree") scale. This form of the MSCS was administered to 183 seventh-graders in a Southern California suburban school. Correlations between the 18 variables (8 demographic-biographic, 7 cognitive, and 3 affective) were computed. Three stepwise regression analyses, using mathematics scores on the Comprehensive Test of Basic Skills as the dependent variable and the remaining variables as predictors, were conducted. A multiple regression analysis, with CTBS mathematics scores as the dependent variable and the eight demographic-biographical, three affective, and MSCS scores as predictors, was also conducted.

4. Findings

Among the correlations of eight demographic-biographical, seven cognitive, and three affective variables with the MSCS, one (socio-economic status) was significant at the .05 level and nine (2 demographic-biographical, 5 cognitive, and 2 affective) at the .01 level. In the regression analyses, scores on the MSCS did not make a significant contribution when the seven cognitive variables were included, but did contribute significantly to predicting the criterion when the cognitive variables were excluded from the analysis.

5. Interpretations

The investigators conclude that ". . . pupils with a higher mathematics self-concept as compared with those of a lower self-concept tended to demonstrate higher verbal and quantitative scholastic aptitude scores as well as higher achievement levels in mathematics, to show slightly stronger identification with school-related activities in the home setting, to assume somewhat greater responsibility for their attainments in school work, and to exhibit considerably more positive attitudes toward their mathematics teachers." (p. 508)

Abstractor's Notes

One of the chronic problems with educational research is that too many fledglings "jump into" or "fall into" an investigation without first surveying the relevant literature. The authors of this article, for example, cite no references and give no theoretical or conceptual background for what they have done. Since this paper appeared in the "Validity Studies" section, their oversight is perhaps pardonable to some extent.

Of course, it may be of interest to have this additional empirical support for the fact that attitude toward mathematics, or "mathematics self-concept" as it is labeled in this article, is related to verbal and quantitative abilities, positive attitudes toward school work and teachers, and a sense of responsibility toward school tasks. But, as a brief survey of the research literature in mathematics education will reveal, these findings have been reported time and again. Furthermore, the MSCS is clearly a less reliable version of the abstractor's Mathematics Attitude Scale and consequently rather superfluous as a research instrument.

Continuing with the theme or repetitiousness in research, if mathematics education is ever to become a scientific discipline rather than a mere potpourri of facts, it is strongly advisable for directors of dissertations in this field to emphasize to their advisees the importance of thorough literature search before launching into an empirical study. As a result of a couple mornings' work in the library, this abstractor recently discovered that over five dozen doctoral dissertations and nearly as many journal articles concerned with attitudes toward mathematics have appeared during the past 4-1/2 years.

Unfortunately, few of the authors of these dissertations and articles on attitudes toward mathematics seem to have conducted more than a cursory review of the research literature or tied their rationale and findings to anything other than the conventional wisdom in education.

In addition to failing to review and/or cite related research, the investigators in the present study can be faulted for: (1) using an inadequate sample size in constructing the MSCS; (2) failing to indicate to the reader that almost all of the correlations of the MSCS with other variables in the pilot study are statistically non-significant; (3) including items on the MSCS that are obviously conceptually different from the majority (items 2 and 9); (4) being unclear about what variables were included in the stepwise regression analyses and what these three analyses entailed.

Rather than constructing more mathematics attitude instruments of which there are presently well over two dozen, further refinements and extensions of existing instruments would seem to be in order. This is particularly true for attitude measures designed for the elementary school level. But beyond the matter of instrument development, of greater concern to researchers in mathematics education should be the questions of how affect toward and ability in mathematics are developed and how they can be modified.

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SE 511 190

THE EFFECTS OF INSTRUCTION ON LENGTH RELATIONS ON THE CLASSIFICATION, SERIATION, AND TRANSITIVITY PERFORMANCES OF FIRST- AND SECOND-GRADE CHILDREN. Johnson, Martin L., Journal for Research in Mathematics Education, v5 n3, pp115-125, May 74.

Descriptors--*Classification, *Cognitive Development, *Elementary School Mathematics, *Measurement, *Research, Basic Skills, Child Development, Instruction, Serial Ordering, [Transitivity]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Elizabeth Fennema, University of Wisconsin-Madison.

1. Purpose

The main purpose was to determine the influence of training on the ability of first and second grade children to classify and seriate objects on the basis of length. A secondary purpose was to investigate the effect of such training on the child's ability to conserve and use the transitive properties of the length relations. Three minor questions related to classification and seriation of length were also investigated.

2. Rationale

Classifying and ordering objects on the basis of length have been identified as the basis of important mathematical ideas by Bruner and analyzed in cognitive acts by Piaget. While Piaget and others have reported three stages in classificatory behavior and three stages related to length seriation, few studies have reported effects of training on attainment of these stages. Since these ideas are important to the learning of mathematics, investigation into the effect of training on their acquisition is essential.

3. Research Design and Procedure

Thirty-nine first grade and 42 second grade children, randomly selected from two schools, were given six, 20 minute instructional sessions before administration of a criterion test. A pretest which measured Conservation of Length Relations (CLRT) and Transitivity of Length Relations (TLRT) was administered and subjects were randomly placed in an Experimental or Control group by grade and school. The Experimental groups received 10 additional instructional sessions of 20 minutes each while Control groups received no further instruction. At the end of the instructional sessions the CLRT, TLRT, a seriation by length test and a classification by length test were given to all subjects. A 2x2x2 factorial design using analysis of variance was used to determine the effect of the two classification and treatment variables on the seriation test. An analysis of covariance was used to analyze the conservation and transitivity posttest scores using the respective pretest scores as covariates. An item-by-item analysis was performed on the

classification test data using contingency tables and Chi-square tests of independence. To determine relationships between transitivity, seriation, and classification, a series of contingency tables was constructed and tested with Chi-square tests of independence.

4. Findings

(a) The main effect of both school and grade on the Conservation of Length Relation Posttest was significant ($p < .05$)

(b) School effect on the Transitivity of Length Relations Test was significant ($p < .05$)

(c) Main effects of both school and treatment on the seriation test were significant ($p < .01$)

(d) All other effects were nonsignificant.

(e) Internal consistency coefficients indicated good homogeneity of test items on all tests except the TLRT pretest.

(f) Contingency tables showed that ability to seriate by length was highly associated with both the relations "longer than" and "shorter than." The ability to insert a stick into an existing series with a baseline was related to inserting into a series without a baseline.

5. Interpretations

The findings indicate that seriation ability of linear objects can be improved by training but the treatment had no effect on transitivity ability. This finding is in conflict with the Piagetian belief that operational seriation implies transitivity. Seriation training was successful in training children to use an algorithm that was not part of an operational scheme.

Children can classify on the basis of self-selected criteria better than they can discover criteria for sticks already classified.

Conservation and transitivity scores were statistically different by school due perhaps to differing socio-economic levels of school populations.

Using different material results in different degrees of success in seriation.

Abstractor's Notes

Several minor questions concerning the research design, probably due to inadequate reporting, come to mind. What attempt was made to control the teaching variable? What was included in the instructional sessions: specific, direct instruction or guided discovery? Were the subjects

taught individually or in groups? Three major areas also concerned the abstractor. First, does not a study of this type, which is focused on Piagetian beliefs, violate basic tenets of the Piagetian theory? Piaget holds that any change in a cognitive structure takes place over a rather lengthy period of time. An attempt to change such a structure in 10 instructional lessons is a parody of Piagetian theory. He also cautions that any one test of a scheme, such as seriation by length, measures only a symptom or minor portion of the schema. Another such test in a different setting might give totally different results. Secondly, a glib remark totally without support explaining the difference in school score as being attributable to socio-economic level of the school is evidence of sloppy thinking on a researcher's part. Such statements attempting to explain a result on the basis of poverty are without merit. Finally, the purposes of the study overwhelm the study itself. It appears that too many complex questions are being investigated in a very small study.

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EJ 090 178 SE 510 249

THE EFFECTIVENESS OF TEXTBOOK, STUDENT-GENERATED, AND PICTORIAL VERSIONS OF PRESENTING MATHEMATICAL PROBLEMS IN NINTH-GRADE ALGEBRA. Kulm, Gerald; And Others, Journal for Research in Mathematics Education, v5 n1, pp28-35, Jan 74.

Descriptors--*Algebra, *Problem Solving, *Research, *Secondary School Mathematics, Ability, Diagrams, Instruction, Learning Theories, Teaching Methods, [Research Reports]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by James M. Sherrill, University of British Columbia

1. Purpose

To investigate the relationship between aptitude and the effectiveness of textbook, student-generated, pictorial, textbook with pictorial, and student-generated with pictorial presentations.

2. Rationale

Within the area of structure and mode of presentation of word problems there is concern over the effectiveness of verbal and pictorial presentations. Runquist and Hunt (1961) indicated that in a concept-learning task, verbal presentation was superior to pictorial presentation. Koenke (1970) found that relevant pictures added little to the recall of descriptive paragraphs and that specific directions to attend to the pictures were not effective.

Also within the area of study is the question of the relationship between aptitude and mode of presentation. Although Cronbach and Snow (1969) and Gagné and Gropper (1965) did not find evidence of spatial or verbal aptitude interactions with the learning of verbal or pictorially illustrated concepts, Sherrill (1970) demonstrated that in presentations of mathematical word problems, prose together with an accurate picture was superior to prose alone, which, in turn, was superior to prose together with a distorted picture.

Kilpatrick (1960) found that word-problem length was the best predictor of problem difficulty, and that variables such as vocabulary difficulty and sentence length were not useful predictors of problem difficulty. Keil (1964) showed that subjects that wrote and solved their own problems performed better on an achievement test than subjects who solved textbook problems.

3. Research Design and Procedure

The subjects, 116 ninth-grade algebra students, were asked to solve word problems selected from algebra and pre-algebra textbooks to represent a variety of content and levels of difficulty. The level of difficulty of a problem was determined by the number of subjects who answered the particular problem correctly. There were five versions of

the 10 problems; a) the textbook version (T), b) the student version (S), c) the pictorial version (P), d) the textbook version with the accompanying picture (T + P), and e) the student version with the accompanying picture (S + P). The pictorial versions that minimized the verbal content of the problems were shown to three judges who confirmed the pictures' fidelity to the problems. In a preliminary phase of the study, six algebra students were given the pictorial versions of the problems and were required first to solve the problems and then to write their own version of each problem.

The subjects were randomly assigned to one of the five treatment groups. In each group a problem was projected on the screen for one minute, during which time the subjects could write down any information under the "notes" section of the answer sheet. The projector was then turned off and the subjects were allowed three minutes to solve the problem on the "solution" section of the answer sheet. The procedure was continued until all 10 problems were presented. A sample problem was presented first.

Five measures of subject performance in solving the problems were obtained: a) correct answer, b) correct method; that is, the use of the correct arithmetic operation and procedure, c) percentage of total words and symbols copied during presentation, d) percentage of critical information copied during presentation; that is, the numbers and relations necessary to solve the problem and a statement of the question of the problem, and e) presence of a sketch in the notes or solution of the problems.

Groups were compared on the basis of mean performance on a) the three easiest problems, b) the three medium-difficulty problems, c) the four hardest problems, and d) all 10 problems, for each of the five dependent measures.

A 5 X 3 treatment by IQ (low: 92-109, medium: 110-119, high: 120-137) unequal-cell analysis of variance was carried out for each dependent variable on the different levels of problem difficulty. In each ANOVA in which there was a significant ($p < 0.05$) treatment-by-IQ interaction, a one-way ANOVA over the treatments was performed within each IQ group.

4. Findings

Significant correlations with IQ were found for number correct and correct method. The dependent variables that were significantly correlated were: number correct and correct method, percentage of words copied and percentage of critical information copied, percentage of words copied and the presence of a sketch, and correct method and percentage of words copied ($r < 0$).

There were significant IQ main effects for all problem-difficulty levels on number correct and correct method. A significant treatment-by-IQ interaction for correct method on the easiest problems was found

which resulted in finding significant treatment effects within IQ groups for the low IQ group. Subsequent Newman-Keuls tests within the low IQ group showed that T was superior to all treatments except S and T + P was the least effective of all the treatments.

At all problem-difficulty levels, there were significant treatment effects but no significant IQ effects for the percentage of words copied. For all 10 problems, a Newman-Keuls test showed that subjects in P and T + P copied a significantly greater percentage of words than subjects in the other treatments. Significant treatment effects for the scores on all 10 problems were found for the presence of a sketch with P being superior for all IQ groups. On the difficult problems, the medium and high IQ groups made significantly more sketches than the low IQ group. There was significant treatment-by-IQ interaction for the easiest problems. Newman-Keuls tests showed treatment P superior to the others in the medium and high IQ groups.

5. Interpretations

The finding that T and S were superior for low IQ subjects on correct method suggests that pictures may have interfered with problem solving. Although P was superior to the others when the criteria were the percentage of words copied and the presence of a sketch, this advantage did not appear to facilitate solving the problems, since P was not superior when the criterion was the number correct or correct method. The T language may have been familiar to the low IQ subjects and the other versions more difficult due to their novelty.

It appeared that obtaining the information necessary to solve a problem did not depend on the total amount of information copied. In fact, the significant negative correlation between the percentage of words copied and correct method indicates that copying the entire problem during presentation may have interfered with solving the problem later. Perhaps the subjects who copied fewer words did so because they thought about what they were copying and attended only to the critical information that facilitated solving the problem later.

The difficulty that less able subjects had with the problem was not in recognizing and recording the information necessary to solve the problem but rather in putting the information together correctly into an equation. The results of the present study indicate that students may comprehend a problem but not have the skill to synthesize information and solve the problem.

Abstractor's Notes

Most of the questions that arise concern the different versions of the material. The student-generated versions (S, S + P) were developed by six algebra students who "were given the pictorial versions of the problems and were required first to solve the problems and then to write their own versions of each problem." How were these six students

selected? They had to solve all 10 problems so they must have been very good students. The students generated six versions of the problems. Which version is the one that was selected to be used and how was it selected?

Considering the pictorial version (P) one unstated restriction on problem selection must have been that the problem could be represented pictorially. The pictorial version "minimized the verbal content." P -vs- T is not verbal -vs- nonverbal. In fact, in one of the given examples, the pictorial version has only 5 words less than the textbook.

It would have been interesting to know how "percentage of critical information copied" was computed. If a subject copies every word of a problem, he has all the critical information, but that subject should score lower than the subject that copies just the critical information and nothing more.

Readers of the original article should be aware that Table 3 shows a significant IQ effect for percentage of words copied which, based upon the text of the article, must be a typographical error.

Finally, lack of discussion due to the very finite confines of a journal article combined with some very high (number correct and correct method had a correlation of 0.921) correlations between dependent variables raise the questions of why ANOVA was implemented for each of the five dependent variables and why MANOVA was not substituted.

Being involved in the area under study the abstractor found the Kulm, et al study of great interest. Overall, the study is well done and generates questions of research importance.

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EJ 078 168 270 SE 508 619

THE EFFECT OF A CLASS SIZE ON THE LEARNING OF MATHEMATICS: A PARAMETRIC STUDY WITH FOURTH-GRADE STUDENTS. Moody, William B., Journal for Research in Mathematics Education, v4 n3, pp170-176, May 73.

Descriptors--*Class Size, *Elementary School Mathematics, *Instruction, *Research, Mathematics Education, Number Concepts

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Donald J. Dessart, The University of Tennessee, Knoxville.

1. Purpose

To compare the achievements of students of four different class sizes (1, 2, 5, and 23) after a 30 minute teaching session concerning 10 mathematical objectives on exponential concepts.

2. Rationale

The authors reported that previous research had indicated that class size seems to have little effect upon the learning process. However, they identified several questions that had not been considered in previous investigations. For example, most studies had dealt with class sizes of 15 or more, whereas few studies were concerned with the effects of very small group instruction. In addition, there were variables in previous studies that simply could not be adequately controlled. A student, for example, realizing that he may not be learning in a large class may decide to spend considerably more time in study outside of class to compensate for his learning loss. The investigators felt that a study which would test students immediately following a teaching session would provide more positive control over such variables.

3. Research Design and Procedure

All the fourth-grade students of three schools in a northern Delaware school district were pretested on an examination over 10 instructional objectives on exponential concepts. Those students who were familiar with the concepts as determined by the pretest were eliminated from the study. From the remaining population, 249 students, 83 from each of the three schools, were randomly selected for the experiment.

Four types of instructional groups were formed in each of the three schools: (a) Group 1-1; (b) Group 1-2; (c) Group 1-5; and (d) Group 1-23, where the first numeral indicates the number of teachers and the second shows the number of students in each group. Within each of the three schools, 20 sessions of Group 1-1, 10 sessions of Group 1-2, four sessions of Group 1-5, and one session of Group 1-23 were conducted. The 83 pupils of each school were randomly assigned to the four types of groups.

Seventeen undergraduate junior- and senior-level elementary education majors served as teachers. Of the 17 teachers, 14 taught for only one day in one of the three schools, two participated on two days in two schools, and one taught all three of the days in three schools. Only seven of the 17 teachers participated in any one school on any one day; however, they were assigned to a total of 35 teaching sessions scheduled in such a way that all taught at least two Group 1-1 sessions, all taught at least one Group 1-2 session, no one taught more than one Group 1-5 session, and no one taught both a Group 1-5 and a Group 1-23 session.

One week prior to the experiment, which lasted three days, each teacher was given a list of 10 instructional objectives with examples and mathematical discussions. No particular instructional procedures or techniques were suggested for the teachers. On the days of the experiment, they taught their assigned sessions with the students being tested immediately following instruction.

The post test consisted of 20 questions with two items designed to measure the attainment of each instructional objective. The split-half reliability for the test using the Spearman-Brown Formula was .89.

4. Findings

A three (schools) X four (class sizes) analysis of covariance was performed on the post test results with the pretest scores utilized as a covariate. The adjusted grand means for each of the groups were as follows: Group 1-1 (11.50); Group 1-2 (10.07); Group 1-5 (9.23); and Group 1-23 (7.65). Newman-Keuls comparisons of the means indicated that the achievement in Group 1-1 was significantly greater than all other class sizes. Although no significant difference was found between Group 1-2 and 1-5, both Group 1-2 ($p < .01$) and 1-5 ($p < .05$) were significantly greater than Group 1-23.

Class size interacted with the three school populations ($F(6,236) = 2.4$, $p < .05$), but the investigators felt that this significant interaction was due primarily to the achievements of Group 1-5. In two of the schools the mean post test scores, primarily because of Group 1-5, did not have the same ordering as that of the grand means for all three schools.

5. Interpretations

The researchers concluded that "...manipulation of class size does influence the learning of selected mathematical content when that manipulation takes the form of reductions in size from an average class-size standard." They further cautioned, that "...although small-group instruction was incremental when compared to large-group instruction, large-group instruction could be considered more efficient in terms of total learning produced per unit of instructional time (and per teacher)." They were inclined to favor a teaching procedure in which smaller groups of students, perhaps slower students, be provided more small group work

with teacher aides or others while the regular classroom teacher instructs the remainder of the pupils.

Abstractor's Notes

This was a well designed and a well executed study. It dealt with a problem that has both practical and theoretical implications. Certainly class size, although not under the complete control of the teacher, lends itself to rather easy manipulation by the teacher especially if aides or assistants are available to help. The proper utilization of such people is a problem of most practical significance for education.

Class size as related to learning mathematics needs further study. In particular, efforts should be made to control more stringently the teacher variable. Of necessity, this study relied upon undergraduates as teachers, which, of course, raises the question concerning the experience factor. A replication of the experiment with experienced teachers would be most interesting, if such a study were possible; but, perhaps, better control of the experience of the undergraduate teachers is all that one can hope to attain. For example, it is probably true that each of the teachers taught more effectively on the fifth teaching session as compared to the first. The investigators randomly assigned the teachers so that this variable was somewhat under control; however, if the Group 1-23 sessions (of which there were only three) were taught by relatively "inexperienced" teachers, this would seem to have had significant effects upon achievements of students in those groups. In future experiments, the experience factor might be minimized if each teacher could be given opportunities to teach the material to a different group of students before the experiment began.

In addition, it would seem that the methods employed by the teachers would be a variable of considerable consequence, particularly, since teaching sessions were of such short duration. Again, random assignment of the teachers was a most helpful technique here, but one might wonder if greater control of the teaching methods in addition to random assignment might have provided a more valid study.

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EJ 077 483 110 SE 508 616

VALIDATING LEARNING HIERARCHIES FOR SEQUENCING MATHEMATICAL TASKS IN ELEMENTARY SCHOOL MATHEMATICS. Phillips, E. Ray; Kane, Robert B. Journal for Research in Mathematics Education, v4 n3, pp141-151, May 73

Descriptors--*Elementary School Mathematics, *Fractions, *Mathematics Education, *Research, *Sequential Learning, Learning Theories, Organization, Rational Numbers

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Ralph T. Heimer, The Pennsylvania State University.

1. Purpose

The study was designed to determine the relative effectiveness of several different indirect procedures for validating learning hierarchies, namely, the Guttman technique (Torgerson, 1958), the AAAS Method (AAAS Commission on Science Education, 1968), correlation between test items or levels of the hierarchy (Phillips, 1971), and the difficulty of items (Nunnally, 1967).

2. Rationale

The basis for the study rests mainly upon Gagne's assertion that "the design of an instructional situation is basically a matter of designing a sequence of topics." Specifically, the authors are concerned with the development of practical methods of validating such sequences (learning hierarchies).

3. Research Design and Procedure

A learning hierarchy was constructed using a logical (task) analysis for the terminal task of adding rational numbers with like denominators. Altogether, eleven subtasks were identified using this procedure and arranged hierarchically. A test was then constructed to assess mastery at each level in the hierarchy, and was administered to 163 children in grades four through six.

The pass-fail relationship revealed by the foregoing examination were analyzed using the indirect validation procedures mentioned in section 1, and formed the basis for the formation of new orderings of the eleven subtasks, one for each procedure. For comparative purposes, the eleven subtasks were also ordered according to the "usual" textbook sequence, and for a control they were randomly ordered. Thus, in total, seven different subtask arrangements were generated: logical, Guttman, random, item difficulty, correlation coefficient, textbook, AAAS. The materials used in the study consisted of eleven programed instruction booklets, one for each subtask in the hierarchy.

Fourth-grade students were selected to participate in the study on the basis of their performance on two pretests. Pretest I was designed

to determine if the learners had mastered the necessary prerequisites for successfully achieving the skills presented in the programed texts, and Pretest II was designed to determine if the students had already mastered the skills to be taught in the instructional sequence. Only those students who were able to demonstrate mastery of the prerequisites and had not already mastered the specified subtasks were eligible for participation in the study.

A total of 142 students were ultimately selected for the study from an original population of 175, and they were randomly assigned to the seven treatments--one corresponding to each of the seven subtask arrangements. In each treatment, the students were taught the subtasks in the order that had been determined, and the treatments were compared on achievement (of the terminal task), transfer (to the subtraction analogue of the terminal task), retention, and time to complete the instructional sequences, using analysis of variance for multiple groups, unequal n's model (Winer, 1962). A pattern analysis technique (Rimoldi and Grib, 1960) also was used to determine the index of agreement of each ordering with the expected response patterns.

4. Findings

The index of agreement was above .86 for all subtask orderings except the textbook and random sequences. These were .62 and .61, respectively.

There was no overall significant differences found at the .05 level on the ANOVA tests.

Some ad hoc analyses were also cited.

5. Interpretations

The investigators drew the following conclusions, subject to the limitations of the investigation:

(a) The overall efficiency of the learning process, using programed instructional materials, was affected by changing the sequential ordering of the subtasks.

(b) For the content under consideration (addition of rational numbers), sequence had little effect on immediate achievement.

(c) Of the four variables under study, retention appeared to be the variable most susceptible to sequence manipulation.

(d) No sequence maximally facilitated achievement, retention, and transfer, and required less time to complete. However, based on the group means, the AAAS procedure yielded the best sequence overall.

The authors further stated that these conclusions lead to the following implications:

(a) Textbook authors may need to give more careful consideration to the sequencing of subtasks within major topics or subdivisions of a chapter.

(b) Optimal instructional sequences can be derived using learning hierarchies validated from test data.

Abstractor's Notes

The procedures employed by the investigators for "validating" learning hierarchies are interesting from the perspective of a researcher, but how feasible are they for a practitioner? Is it reasonable to simply use logical analysis as the modus operandi for constructing learning hierarchies for use in the classroom, and revise them as deemed necessary by feedback from the learners who interact with them?

Finally, are all the conclusions that have been drawn congruous with the outcomes of the study?

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EJ 075 346 450 SE 508 019
THE EFFECT OF AN ADVANCE ORGANIZER, COGNITIVE SET, AND POST ORGANIZER ON THE LEARNING AND RETENTION OF WRITTEN MATERIALS. Romberg, Thomas A.; Wilson, James W., Journal for Research in Mathematics Education, v4 n2, pp68-76, Mar. 73.
Descriptors--*Instruction, *Learning, *Research, *Secondary School Mathematics, Learning Theories, Mathematics Education, [*Organizer (Learning)]

- and -

EJ 075 347 450 SE 508 020
THE EFFECT OF ORGANIZERS AND KNOWLEDGE OF BEHAVIORAL OBJECTIVES ON LEARNING A MATHEMATICAL CONCEPT. Peterson, John C.; And Others, Journal for Research in Mathematics Education, v4 n2, pp76-84, Mar. 73.
Descriptors--*Instruction, *Learning, *Mathematics Education, *Research, Behavioral Objectives, Learning Theories, Preservice Education, Secondary School Mathematics, [*Organizer (Learning)]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Stephen S. Willoughby, New York University.

1. Purpose

To examine the effect of using three kinds of information related to lesson content (an advance organizer, a cognitive set or knowledge of behavioral objective, and a post organizer) to help in the learning and retention of the lesson content.

2. Rationale

Many teachers of mathematics believe learning is facilitated and retention enhanced if the material is related to information the student already has learned. Knowledge of behavioral objectives (or cognitive set) is also presumed to aid learning and retention. Since 1960 there have been several studies to determine the effects of these three kinds of information and the interaction effects of the various combinations of them. The results of these studies have been mixed, some supporting the use of one or more of these "aids" and others rejecting their use.

3. Research Design and Procedure

Romberg and Wilson used 238 students enrolled in nine eleventh-grade Algebra II classes - three classes each from Grossmont High School in Grossmont, California; East High School in Madison, Wisconsin; and East High School in Wichita, Kansas. The content to be learned was presented in four pages of self-instructional material on radioactive decay adopted from an SMSG supplementary monograph. The advance organizer consisted of two paragraphs designed to get students to recall what they knew about atomic energy and radioactive decay. The post organizer was quite similar

to the advance organizer except that it explicitly emphasized the relationships between what was just studied and the background knowledge. The cognitive set (or behavioral objective students were given) was:

> Upon completion of the study of the following materials, you are expected to know the general law of radioactive decay and be able to solve simple problems based upon the application of this law.

Two similar 24-item completion tests were used to assess immediate learning and retention after one week. In each test, 20 items required calculation of changes and new amounts of radioactive elements and four items dealt with the general relationship of change and relative rate of decay. The two tests were identical except for the quantities of elements presented.

Eight different booklets were prepared allowing for every possible combination of inclusion or omission of the three organizers. Booklets were randomly assigned to student within each class.

A 2 x 2 x 2 factorial model was used with the independent variables being the presence or absence of each of the three organizers, and the dependent variables being the immediate test score and the one-week retention test score. Twenty-two cases were randomly discarded in order to allow use of an equal-cell ANOVA computer program, leaving 216 students.

Peterson et. al. conducted three independent replications of an earlier study by Peterson in which he had found a negative main effect for post organizers on the retention test. The content to be learned was presented in five pages of self-instructional material on network tracing. The advance and post organizer both consisted of a discussion of the Konigsberg bridge problem with the advance organizer including a suggestion that it could be solved diagrammatically and the post organizer actually providing the diagrammatic solution. The behavioral objective stated that students ought to be able to solve simple problems requiring application of the general rule for tracing networks.

Two twelve-item multiple choice tests used in Peterson's original study were used to assess immediate learning and retention after one week. Bright used still a third test to evaluate retention after three weeks.

Analysis was essentially the same as that described above for the Romberg-Wilson study. Experimenters' names, number and descriptions of subjects, location and number of minutes allowed for the tests, are indicated below:

Lovett and Thomas	136 eighth-graders, Oneonta, N.Y.	42 minutes
Peterson	112 eighth-graders, Marshall, Ill.	55 minutes
Bright	259 students in math for elementary teachers, Northern Illinois University	50 minutes

4. Findings

The Romberg and Wilson study produced significant ($p < .05$) results for the main effect due to the cognitive set and for the interaction of the advance organizer and the post organizer on the retention test (no F statistics were significant for the learning test). The effect of giving students the cognitive set (or behavioral objective) was positive. The effect of giving the students either the advance organizer or the post organizer BUT NOT BOTH was positive - giving the students both (or neither) produced results that were less favorable than giving them only one.

None of the Peterson, et. al. studies produced results supporting the results of the earlier Peterson study (negative main effect for post organizers on the retention test). Indeed, only the Lovett and Thomas study produced any results that were significant ($p < .05$). They found a significant interaction between the advanced organizer and post organizer consistent with the Romberg-Wilson results except that the Lovett-Thomas F statistics were significant only on the learning test, while the Romberg-Wilson results were significant only on the retention test.

5. Interpretations

Romberg and Wilson call attention to their separation of the advance organizer and cognitive set to partially explain some of the differences between their study and previous studies and argue that future studies should consider this distinction. They also call attention to the mutual interference of the advance and post organizers but refuse to make an attempt to explain this phenomenon in theoretical terms.

Peterson, et. al. conclude that the results of Peterson's earlier study suggesting an inhibiting effect of the post organizer was probably due to chance, but suggest that since one of their three studies supports Romberg and Wilson's finding of interaction between advance organizer and post organizer, no conclusion about this factor is justified. They also call attention to the fact that their retention scores were higher than their immediate learning scores (the contrary was true in the Romberg-Wilson study) and offer several plausible explanations.

Both sets of authors suggest that further research is in order. Peterson, et. al. suggest that determination of learner characteristics that might accurately predict the success of various combinations of organizers should be investigated. They further suggest that conflicting research results may have occurred because a theoretical construct of an advance organizer has not yet been defined for this content area.

Abstractor's Notes

An obvious hypothesis regarding the interference of advance and post organizers relates to the question of time. The Lovett and Thomas results supporting the Romberg and Wilson findings were obtained when the subjects were given substantially less time to complete their study and take the

test than was given in the Peterson and Bright experiments. Presumably, reading and thinking about two organizers requires more time than reading and thinking about one organizer. Further, since the tests explicitly do not cover material in the organizers, time and energy spent studying them can be thought of as wasted for the purpose of the test except for such positive effects as helping the student to organize the material and see its relevance to his previous life. Perhaps, when there is limited time, one go-around at relevance and organization is sufficient and two is too much.

A further cautionary note that should be heeded before accepting results of any experiments of this sort, is that tests often do not test the learning that most adults would think important. In the Romberg-Wilson study, for example, many adults would believe that the untested material in the advance and post organizers was more important than the material that was tested (and described in the cognitive set); but a student who concentrated on that material to the detriment of the material to be tested would probably do poorly on the test.

One possible inference from these and other experimental results is that the more clearly you tell a student what will be on his next test, the better he is likely to do on that test. Of course, such high scores would reflect better learning only insofar as the test measured all important learning; and, perhaps it is true that the better the test in this regard, the harder it is to tell the student what will be on it.

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EJ 093 516 SE 510 715

THE RELATIONSHIP BETWEEN PERFORMANCE ON PIAGETIAN TASKS AND IMPULSIVE RESPONDING. Schwebel, Andrew I.; Schwebel, Carl R., Journal for Research in Mathematics Education, v5 n2 pp98-104, Mar. 74.

Descriptors--*Conservation (Concept), *Elementary School Mathematics, *Performance Factors, *Research, *Student Characteristics, Cognitive Development, Learning, Mathematics Education, Self Control, [Piaget (Jean)]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Leslie P. Steffe, University of Georgia.

1. Purpose

Schwebel and Schwebel hypothesized that impulsive responders would be more likely than reflective responders to under-use their capabilities in problem solving using Piagetian tasks. In addition to this hypothesis, Schwebel and Schwebel were concerned with three pragmatic questions; the first concerning individual differences in under-use of capabilities in problem solving, the second with long term consequences of under-use of capabilities in problem solving and the third with enhancing use of problem solving capabilities.

2. Rationale

As Piagetian - cognitive development theory has shown, as children develop logical problem solving capabilities, they retain and sometimes use their less mature capabilities. In fact, the logical problem solving capabilities emerge from idiosyncratic ones. In a study reported by Callahan and Passi, a non-statistically significant tendency appeared for reflective children to outperform impulsive children on a conservation of length task. A good possibility exists, then, that if children are not allowed to respond for a specified amount of time, they would use problem solving capabilities available to them during the time they were not allowed to respond. Lower and middle class children were used as subjects because socioeconomic - class has been shown to be associated with reflective - impulsive responding.

3. Research Design and Procedure

School personnel selected 30 lower and 19 middle socioeconomic-class first and second grade children. All but four were Caucasian. The middle socioeconomic-class children were used as controls and the lower socio-economic-class children were randomly assigned to a control and an experimental group. The experimental group had an imposed-latency period of 15 seconds before being allowed to respond to the problems.

Two class inclusion tasks and a conservation of number task were individually administered to each child following warm-up verbal tasks. The warm-up tasks served to acquaint the children in the experimental

group with the 15 second response latency procedure and to give the examiner a chance to establish rapport with the children.

4. Findings

(a) Correct and incorrect responses were found to be independent of experimental and control groups for the lower class population on one of the two class inclusion problems. For number conservation and the other class inclusion problem, tests for dependency were significant. Tests were not reported for the middle class control groups.

(b) Eighteen out of 28 responses for the class inclusion problem were correct for the experimental group. For the control groups, the frequencies were nine out of 32 (lower class) and eight out of 38 (middle class).

(c) Median response latencies for the lower class control group were two seconds on one of the class inclusion problems and three seconds on the other for the correct responders, and two seconds on each for the incorrect responders. For the middle class control group, the respective mean latencies were seven and four seconds, and three and three and five tenths seconds.

5. Interpretation

Schwebel and Schwebel offer the following interpretations of the data.

(a) The authors believe that a latency period has use primarily under conditions where the problem posed is within an individual's capabilities and where correct solution calls for thoughtful reasoning.

(b) It is assumed that the individual uses the latency period to survey his repertoire of problem solving strategies and to select and implement the one he thinks is most appropriate.

Abstractor's Notes

This study deserves being extended. The findings are potentially significant if more information were present concerning the solution strategies employed by the children under the conditions of imposed latency. Each child should be used as his own control under imposed latency and no-imposed latency conditions, so that possible differences in individual solution strategies could be studied. Because counting is stressed in the first and second grades, it is entirely possible that the questions posed would elicit quantitative solution strategies rather than logical strategies. In the class inclusion problem, rather than compare the subsets, a child may revert to counting all the objects, then the objects in a subcollection and make the correct conclusion.

Other task variables may also be important in the class inclusion and conservation of number tasks. If a child is told to count before solution, this could override the imposed latency condition. So, a two by two design could be employed across tasks and age, where the factors are Imposed-Latency vs. No-Imposed Latency and Counting-Instructions vs. No-Counting Instruction. I would hypothesize an interaction between these two variables where the children who receive counting instruction perform equally well across the two latency conditions and the children who do not receive counting instructions perform better under imposed latency conditions than do those under no imposed latency conditions. If Age is used as a blocking variable, more detailed information would be available than in the present study as only three beginning first grade children out of 120 have been observed displaying any evidence of class inclusion in a test administered in an experiment in the fall of 1974.

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EJ 090 177 SE 510 248

HIGH VERSUS LOW GEOMETRY ACHIEVERS IN THE NLSMA Y-POPULATION. Sowder, Larry, Journal for Research in Mathematics Education, v5 n1, pp20-27, Jan 74.

Descriptors--*Achievement, *Geometry, *Predictor Variables, *Research, *Secondary School Mathematics, Ability Identification, Mathematics Education, Predictive Ability (Testing), [National Longitudinal Study Mathematical Abilities, Research Reports]

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Thomas A. Romberg, University of Wisconsin-Madison.

1. Purpose

The purpose of this study "was to attempt to determine whether any of several measures could be used to distinguish students (who were unsuccessful in geometry) from successful students." (p.20)

2. Rationale

This study is based on an assumed aptitude by instruction interaction. If such an interaction exists, then prior aptitude data could be used to predict probable success of subjects prior to this being instructed in geometry.

3. Research Design and Procedure

The data for the study was selected from the NLSMA Y-population geometry students (a data pool for some 16,000 students gathered in the mid-1960's). A variety of tests given in that longitudinal study to the population prior to their study of geometry were selected as potential for success in geometry. Sub-populations of high-geometry achievers and low-geometry achievers were identified. The analysis was carried out through stepwise discriminant analysis.

4. Findings

Nine different discriminant analyses were carried out. The results indicated that correct assignments to high and low groups were possible for 75% to 95% of the sample. The results suggest that certain scales, Informal Geometry 4, Paper Folding 2, Maps 2, Letter Puzzles 2, Debilitating Anxiety 2, Algebraic Expressions 3, Algebraic Equations 4, and Analysis 3, correctly classified 93-94% of the high and low groups respectively.

5. Interpretations

Four of the eight measures were prior achievement measures. In particular, the informal geometry scale (a five-item scale) stood out as

being a particularly good discriminator. This scale deals with measurement ideas in a non-routine way. The paper folding test is designed to measure ability to manipulate or transform the image of spatial patterns into other visual arrangements. The importance of this would lead one to the hypothesis about a cause effect relationship which needs further investigation. The letter puzzles and maps are intended to measure ability to handle novel mathematical situations and thus are an interesting way of assessing a student's aptitude for learning information from new definitions.

Abstractor's Notes

This is an interesting study which I would classify as creative data snooping. Certainly the NLSMA Data Bank, which has not been adequately used by researchers in the field, should be used in this way. Professor Sowder has been careful in selecting his sample and looking for hypotheses which might explain differences in geometry achievement. However, the study itself does not lead to many new ideas.

The limitations of the study are several. However, several were not under Professor Sowder's control. For example, the data source may not be representative of today's students. Second, the criteria for choice of variables is limiting. Since there was so many variables in the longitudinal study, one might question why non-test data (such as socio-economic) economic) were not included in the regression analysis. Also, why was information from the C-variable analysis (NLSMA Volumes 21 to 26) not looked at as a rationale for choosing predictor variables? In addition, since the sample was so large, it would seem reasonable for one to separate the population randomly into two sets, generate regression equations from one sample and test the validity of those equations on the second sample. This would have added considerably more to the results.

Finally, unless one begins to examine the utility of this information (actually making decisions) studies such as this are no more than intellectual exercises. One would hope that such information might be used by teachers in designing and carrying out alternate instructional procedures.

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SE 511 195

THE INFLUENCE OF VERBALIZATION OF DISCOVERED NUMERICAL- OR SORTING-TASK GENERALIZATIONS ON SHORT-TERM RETENTION IN CONNECTION WITH THE HENDRIX HYPOTHESIS. Sowder, Larry, Journal for Research in Mathematics Education, v5 n3, pp167-175, May 74.

Descriptors--*Discovery Learning, *Learning, *Mathematics Education, *Research, *Verbal Learning, College Mathematics, Elementary School Teachers, Language Usage, Learning Difficulties, Learning Theories

Expanded Abstract and Analysis Prepared Especially for I.M.E. by Roland F. Gray, University of British Columbia.

1. Purpose

The purpose of this study was to, "... seek evidence concerning the following question: Does the manner in which one verbalizes a discovered generalization affect the short-term retention of ability to use the generalization?"

2. Rationale

The Hendrix hypothesis of 1974, viz, "... verbalizing a generalization immediately after discovery may actually decrease transfer power," was reviewed in terms of the findings of subsequent studies which examined the same or similar questions in one or another manner. The later studies showed neither consistent support for, nor rejection of the Hendrix hypothesis. However, the literature review led the investigator to examine not only whether or not verbalization may interfere with retention but also whether or not the source of the generalization; external or internal, or the mode of the generalization; written or oral, affected retention.

3. Research Design and Procedure

(a) Research model: the basic research design is exemplified by the following model:

Mode \ Source	Subject	External
Written	1. Subject writes generalization.	2. Subject reads generalization.
Oral	3. Subject speaks generalization.	4. Subject listens to generalization.
None	5. There is no required verbalization of the generalization.	

(b) Research question: the research question, as stated, was, "....Are there differences in the effects of the five verbalization combinations on short-term retention of the ability to use discovered generalizations when (1) the subjects are aware of the verbalization combination expected of them and (2) differences in the subjects with respect to mathematics achievement and number of trials taken for discovery are taken into account?"

(c) Subjects: The subjects were drawn from 221 students in an elementary university mathematics class and ten were assigned at random to each of the five verbalizations treatments. The total sample size was 50.

(d) Procedure: Three sorting problems and two shortcut problems leading to generalizations were developed from a pilot study. For the sorting problems subjects were asked to sort items into four classes by some rule which was to be discovered and stated according to the four verbalization treatments and not stated for the fifth treatment. Four successful sortings were taken as evidence that the rule had been discovered. The short cut problems were treated in a similar manner except that two correct responses were taken as evidence of the rule's having been discovered. All subjects were tested individually.

Following a ten minute interval in which all subjects played a maze game a five item retention test similar to the previous tasks was administered.

(e) Tests: Covariate measures were the number of trials necessary to reach the generalizations and a mathematics usage score taken from the American College testing program battery.

The criterion measure was the score on a five item retention test with sorting and short-cut problems isomorphic to the discovery tasks.

(f) Data Analysis: The retention scores were analyzed by ANOVA and ANACOVA to test for significance of differences in scores as related to the five verbalization treatments.

4. Findings

No significant differences were found between retention scores and the five verbalization treatment effects. No significant differences were found between mode effects, between source effects nor among interactions.

5. Interpretations

The author noted as limitations the nature of the population, the discovery tasks, the retention test, and style of administration. The

author also noted that the ten minute retention interval was too short and further that the retention test lacked power to detect differences in performance that may have existed. Mean scores on the retention test ranged from 3.9 to 4.2. However, the author concluded from the non-significant findings that this study did not support the Hendrix hypothesis.

Abstractor's Notes

1. Given the growing realization that a study of research in education rarely, indeed, reveals any consistent and conclusive findings in support of any particular educational treatment it seems increasingly necessary to conduct more careful and numerous studies of limited hypotheses in an attempt to find definitive support or rejection. In this respect the present study deserves notice. Graduate students might well find this type of study valuable as a guideline in shaping their own research plans.

2. The author noted and commented on the serious limitations of this study as indicated previously. The analysis procedures were very carefully and correctly selected. However, given the obvious lack of power of discrimination of the criterion measure it is difficult to accept uncritically the conclusion that the findings do not support the Hendrix hypothesis. Only in a most limited way could this be said to be true. Certainly, we must take care not to infer that the Hendrix hypothesis is rejected.

3. Finally a replication of this study might more profitably be done with younger children whose cognitive styles may be more flexible, less confined by habit, apprehension or preconceived generalization patterns.

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EJ 078 794 520 SE 508 617

THE EFFECTS OF TEST ANXIETY AND SUCCESS/FAILURE ON MATHEMATICS PERFORMANCE IN GRADE EIGHT. Szetela, Walter, Journal for Research in Mathematics Education, v4 n3, pp152-160, May 73.

Descriptors--*Anxiety, *Performance Factors, *Research, *Secondary School Mathematics, *Testing, Mathematics Education, Sex Differences

Expanded Abstract and Analysis Prepared Especially for I.M.E. by James M. Moser, University of Wisconsin - Madison.

1. Purpose

The major hypotheses tested in this study were:

(a) Performance of high-anxiety subjects on a mathematics performance test will be inferior to the performance of low-anxiety subjects on the same test.

(b) Performance on a mathematics performance test of subjects operating under a failure condition will be inferior to the performance of subjects operating under a success condition.

(c) Subjects operating under a failure condition will report higher mathematics test anxiety than those operating under a success condition.

(d) Girls will report higher mathematics test anxiety than boys.

2. Rationale

Previously reported studies dealing with test anxiety and success/failure conditions have had conflicting results. In a previous study, the author has had some difficulties interpreting data because of a significant correlation between test anxiety and intelligence. The present report deals with a re-analysis of the previous data of his study, this time with intelligence scores being used as a covariate.

3. Research Design and Procedure

All 325 students of an eighth grade, all-white middle class junior high school in Georgia were potential subjects. Due to various constraints such as availability of previous test scores and presence during the experimentation, the number of subjects was reduced to 192, 101 of them boys. IQ scores based upon the California Test of Mental Maturity Short Form were taken from school records and test anxiety scores were obtained two weeks prior to experimentation by administering the Test Anxiety Scale for Children (TASC). A total of 66 Ss were classified as low (scores 0 to 11), 62 as medium (scores 12 to 16) and 64 as high (scores 17 to 30) on the TASC.

The treatment constructed by the investigator consisted of a lesson on the mathematical concepts of network, vertex, region, and arc, followed by the presentation of two problems constructed to induce failure or two problems constructed to elicit success. A mathematics anxiety test, the Mathematics Debilitating Anxiety Scale as used in NLSMA, and a 14-item mathematics achievement test constructed by the investigator, were administered immediately following the treatment. Both treatments and both dependent measurements were carried out within the class period.

The data were analyzed by ANCOVA with IQ as the covariate. The hypotheses of homogeneity of variance and homogeneity of regression were both tested and no significant differences were found in variances between groups or in slopes of regression lines.

4. Findings

The effect of test anxiety on mathematics performance was barely significant ($p = .05$) when mathematics performance was viewed as a linear function of test anxiety level. The quadratic component of the trend in mathematics performance as a function of test-anxiety level was not significant. The effect of success/failure on mathematics, and on mathematics test anxiety performance was not significant. Girls did report a significantly higher mathematics test anxiety score than boys, but this is probably due to the fact that girls measured higher in overall test anxiety. As might be expected, the relationship between test anxiety and mathematics test anxiety is extremely high. The author also reports that interaction between sex and test anxiety was significant when mathematics anxiety was viewed as a quadratic function of test anxiety ($p < .02$).

5. Interpretations

The question of the effects of text anxiety on mathematics learning is still cloudy. An unexpected result was the absence of any significant effects due to the success/failure treatment. Four reasons for this were advanced. First, the two "failure" problems may have evoked too little emotional response or ego threat. Second, the preceding mathematics lesson may have provided opportunities to experience success or failure, thus neutralizing the subsequent success/failure treatment. Third, the immediately impending mathematics performance test may have presented a threat far more devastating than could be mediated by success or heightened by failure on two problems. Fourth, the mathematics test anxiety measuring instrument may not have adequately measured what it was purported to measure.

Abstractor's Notes

I must admit immediately to a very strong bias against studies in which the experimental treatment lasts less than an hour. I simply question the generalizability of any of the results. Therefore, I do have

some reservations about this study. The mathematical lesson that was given was not adequately described. Were all children taught by the same teacher? If not, how was teacher variability controlled? Were the materials programmed in nature? By my estimate, a typical junior high school mathematics class lasts about 45 minutes. With the other treatment and the two tests administered, I would guess that the mathematics lesson treatment lasted about 10 to 15 minutes. How much of real importance can be learned in that amount of time?

With respect to the concern about the lack of effect of the success/failure treatment, I would submit that perhaps the subjects did not perceive of the treatment as having any affective loadings toward success or failure. Clearly the entire situation must have been identified by them as being experimental and, therefore, of no real or lasting concern to them. Perhaps then, the two problems created no stressful situation at all. In short, I wonder, at least from what was described in this article, how well defined the two experimental treatments really were and whether this study could be replicated.

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